# A REVIEW OF INDIAN SPECIES OF *Metaphycus* (HYMENOPTERA: ENCYRTIDAE)

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BY

**SHAHID BIN ZEYA**

DEPARTMENT OF ZOOLOGY
ALIGARH MUSLIM UNIVERSITY
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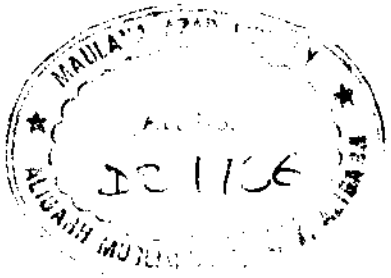

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I certify that the dissertation entitled **"A review of Indian species of Metaphycus (Hymenoptera: Encyrtidae)"** contains the original work done by **Mr. Shahid Bin Zeya.** The work was carried out by the candidate under my supervision. I allow Mr. Shahid Bin Zeya to submit it to the Aligarh Muslim University, Aligarh, in partial fulfilment of the requirements for the award of the degree of **MASTER OF PHILOSOPHY.**

Mohammad Hayat

**(M. Hayat)**
Reader

CONTENTS

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## INTRODUCTION

The species of the encyrtid genus Metaphycus Mercet are primary parasitoids of scale insects belonging to the families Coccidae, Eriococcidae and Asterolecaniidae. As these scale insects infest several economically important fruit trees, the species of Metaphycus keep these coccid pests under check in natural conditions. Because of this parasitic habit, the species of Metaphycus have been used in the biocontrol of several scale insects (DeBach, 1964, for a review).

The genus is represented in the Indian fauna by only 15 species (including one recorded here for the first time), and most of these described during the past three decades. Until about 1965, only three species were known from India (Ayyar 1925; Mani, 1938). In 1965, Agarwal described one species and Alam (1972) described a second species. A major contribution to the Indian species of the genus was made by Shafee et al (1975). In this paper, the authors described five species and recorded one species from India. In a recent catalogue (Hayat, 1986) 12 species were listed as occurring in India.

It is at once obvious that the few species known from India may not represent more than a fraction of the species actually present in India. It is very likely that further more intensive and extensive surveys in India may yield a large number

of species, and eventually the Indian fauna of Metaphycus may prove to be as rich as the Afrotropical fauna.

In the present thesis, the author has reviewed the Indian species of the genus, and provided brief diagnosis of the species and a key for the identification of known species. This is being done at this stage to facilitate a planned revision of the Indian species of the genus.

## MATERIAL AND METHODS

The present review is based on several specimens from the collection of M. Hayat. These were collected during the last 15 years, and mostly consist of specimens obtained from known coccid hosts.

For the purpose of detail study of the material the following methods have been adapted.

(1) **Preparation of card mounts** : The specimens were mounted on rectangular cards using the method developed by Noyes (1982). Specimens originally preserved in alcohol were critical point dried and then mounted on cards using water soluble glue.

(2) **Preparation of permanent slide mounts** : For the purpose of detail study of body sculpture and for measurement of internal structures, it was necessary to dissect and mount small specimens on slides. The method for slide preparation given by Noyes (1982) was followed.

Drawings of different body parts were made with the help of a camera lucida. The measurements of body parts as well as whole insects were taken with the help of an ocular micrometer with linear scale, placed in the eye lenses of the microscope.

(3) **Scanning electron microscopy** : Detail study of such structures as body sculpture, notaular lines of mesoscutum and sensory parts of antennal sockets were carried out through scanning electron microscopy. For this purpose the specimens were dehydrated in ascending grades of alcohol and critical point dried. The CPD'd specimens were gold coated for scanning electron microphotography.

## Genus Metaphycus Mercet

Metaphycus Mercet, 1917, Bol. R. Soc.Espan. Hist. Nat. 17; 138. Type species Aphycus (Metaphycus) zebratus Mercet, by monotypy (As subgenus of Aphycus).

Mercetiella Dozier, 1926, Proc. Ent. Soc. Washington, 28: 98. Type species Mercetiella reticulata Dozier, by monotypy and original designation. Synonymy by Trjapitzin & Gordh, 1978b: 636.

Oaphycus Girault, 1932, New Rest from Australia X. P.5. Type species Aphycus sanguinithorax Girault, by monotypy and original designation. Synonymy by Noyes & Hayat, 1984: 298.

Melanaphycus Compere, 1947, Univ. Calif. Publs Ent. 8: 5. Type species Pseudococcobius fumipennis Timberlake, by original designation. Synonymy by De Santis, 1981: 14.

Anaphycus Sugonjaev, 1960, Ent. Obozr 39: 372. Type species Aphycus nitens Kurdjumov, by monotypy and original designation. Synonymy by Trjapitzin, 1971: 68.

Notoencyrtus De Santis, 1964, An. Com. Cienc. Pro Bs As, 4: 211. Type species Notoencyrtus guttofasciatus De Santis, by monotypy and original designation. Synonymy by Noyes, 1980: 212.

**Citations** :

Timberlake, 1916: 561-640 (Aphycus, revision of world species).

Mercet, 1921: 194-232 (Aphycus and subgenera, Spanish species).

Mercet, 1925: 7-31 (Taxonomy).

Compere, 1940: 7-33 (African species).

Compere & Annecke, 1960: 375-389 (Taxonomy).

Tachikawa, 1963: 184-194 (Japanese species).

Peck, 1963: 405-425 (Aphycus catalogue of Neartic species).

Erdos, 1964: 97-109 (Aphycus, Hungarian species).

Annecke & Mynhardt, 1971: 322-360 (Metaphycus zebratus-group, South African species).

Annecke & Mynhardt, 1972: 227-274 (Metaphycus insidiosus-group, South African species).

Shafee, Alam & Agrawal, 1975: 78-88 (Indian species).

Trjapitzin, 1976: 5-17 (Key to Palaeartic species).

Trjapitzin, 1978: 295-298 (Key to Russian species).

Gordh, 1979: 924-927 (Catalogue of Neartic species).

De Santis, 1979: 213-217 (Catalogue of Neotropical species)

Hayat & Subba Rao, 1981: 108,115-116 (Catalogue of Indian species)

De Santis, 1981: 14-15 (Taxonomy, catalogue of Neotropical species)

Annecke & Mynhardt, 1981: 1-68 (Metaphycus asterolecanii group, South African species).

Noyes & Hayat, 1984: 298 (Taxonomy; Indo-Australian species)

Hayat, 1986: 110-112 (Catalogue of Indian species)

Noyes, 1988: 85-90 (New Zealand species)

Mani, 1989: 836-850 (Aphycus, Indian species)

Trjapitzin, 1989: 231-247 (Taxonomy; Palaeartic species).

**Diagnosis:**

Head dorsum not more than twice as wide as long, frontovertex width one-sixth to one-third of head width, with ocelli arranged in an equilateral to strongly acute triangle (Fig. 1); head, in front view, slightly broader than high; antennal scrobes distinct but not deep (Fig. 2); mandibles three-dentate, the teeth either sharp or rounded (Fig. 5); maxillary palps 2-4 segmented and labial palp 2-3 segmented (Fig. 5, 19,20). Antenna (Figures) with scape cylindrical to usually flattened and with a ventral expansion, funicle segments usually broader

than long, rarely quadrate to slightly longer than broad; clava 3-segmented in female, unsegmented in male.

Pronotum with a collar and with posterior margin slightly concave (Fig. 6-8); mesoscutum with notaular lines nearly complete (Fig. 26) to only indicated in anterior third of the plate (Fig. 39). Fore wing with marginal vein quadrate to slightly longer than broad, shorter than stigmal vein; post marginal short or nearly absent; linea calva distinct, but interrupted by at least two lines of setae, and usually also closed posterior; filum spinosum present; disc setose to base (Fig. 4). All tarsi 5-segmented.

Gaster subtriangular, generally not longer than thorax; tergum VII with a rounded apex (Fig. 17); hypopygium reaching at most four-fifths along gaster (Fig. 16); ovipositor varying from hidden to strongly exserted; third valvula distinctly articulated with second valvifer. Male genitalia without parameres and each digitus with 2-3 denticles(Fig. 21).

Body in female pale coloured (Yellow, orange or yellow-brown) with minimum of brown to dark infuscation especially on occiput, malar space, pronotum, and dorsum of gaster; pronotal collar always with a brown spot on each postero-lateral side (Fig. 15). Tibiae, especially the middle and hind pair, usually with one or two more or less complete brownish bands (Fig. 28), absent in some species. Males are generally darker than females.

**Differential diagnosis:**

The above characters separate the genus Metaphycus from all the genera considered as closely related to it. These genera are Aenasomyiella Girault, Australaphycus Girault, Beethovena Girault, Nassauia Girault, Zarhopaloides Girault, Aenigmaphycus Sharkov & Voinovich, Xenaphycus Trjapitzin, and Mesaphycus Sugonjaev. None of these genera are known from India, but these can be separated from Metaphycus using the keys to genera given by Noyes & Hayat (1984) and Tryapitzin (1989).

The relationship of Metaphycus with Aphycus is discussed under the chapter dealing with the classification (p.16.).

**Historical Review:**

The genus Metaphycus was initially separated as subgenus of Aphycus Mayr by Mercet (1917) with Aphycus zebratus Mercet (1917) designated as its type species. In his Fauna Iberica, Mercet (1921) proposed two more subgenera, Euaphycus and Aphycoides, the former being regarded as a group of A. hederaceus and the latter as a group of A. matritensis. The subgenus Aphycus s.str. is called the group of A. apicalis and the subgenus, Metaphycus as the group of A. punctipes.

The main distinguishing characters used by Mercet (1921) for separating the subgenera Metaphycus and Euaphycus from Aphycus were as follows:

**Subgenus Metaphycus**: maxillary palps 3 or 4 segmented, labial palps 3 segmented; mesoscutum with traces of parapsidal sutures (notaulices).

**Subgenus Euaphycus**: maxillary palps 2 - or 3 - segmented. Labial palps 2-segmented; mesoscutum entire (without notaulices).

Species of subgenus Aphycus were said to differ from these two subgenera in having uniformly coloured antennae, obliquely truncate clava, and exserted ovipositor.

Mercet (1925) again published on Aphycus and related genera. In this paper, he elevated both Metaphycus and Euaphycus (and also Aphycoides) to generic ranks, and gave a key to genera which he regarded as closely related to Aphycus. In the key couplet 15, these two genera were separated as follows:

15, Species of small size; maxillary and labial palps 2-segmented; mesoscutum without indication of parapsidal furrows-Genus Euaphycus Mercet.

- Species of medium to large size; maxillary palps 4-segmented, labials 3-segmented, exceptionally the former with 3 segments; mesoscutum generally with indications of parapsidal furrows - Genus Metaphycus Mercet.

Since these publications by Mercet leading to the establishment of Metaphycus and Euaphycus as genera distinct from Aphycus (see notes given under classification), several species described earlier in Aphycus were transferred either to Metaphycus or to Euaphycus and several species were described.

Compere (1940) was the first biosystematist to publish a well illustrated account of the African species of Metaphycus. In this study he commented upon the systematic position of Euaphycus and considered it as generically indistinguishable from Metaphycus since, according to him, the only differences between these genera is in the number of segments of palps. He has argued that if the number of segments in the palps is to be regarded as a reliable character at the generic level, then for the sake of uniformity of treatment at that particular level, atleast one more generic name is required to accommodate species in which both the maxillary and labial palpi are 3-segmented. However, instead of following this taxonomically unsound procedure, Compere & Annecke (1960) regarded Euaphycus as a synonym of Metaphycus (but see below for the

inadmissibility of this procedure) and further recognized three species-groups based only on the number of segments in the palps.

zebratus-group : Maxillary palps 4-segmented, labial palps 3-segmented.

insidiosus- group: Maxillary and labial palps each 3-segmented.

hederaceus-group: Maxillary and labial palps each 2-segmented.

These authors also assigned several earlier described species to these three species group.

Graham (1958, also 1969) pointed out that the lectotype female of Encyrtus hederaceus Westwood (1837), which was designated as the type species of Euaphycus by Mercet (1921), albeit on a specimen misidentified by Mercet as hederaceus, is in fact a species of Aphycus and very closely related to its type species, A. apicalis (Dalman). This settles the systematic position of Euaphycus as being a synonym of Aphycus.

Tachikawa (1963) agreed with Compere & Annecke (1960) in considering Euaphycus as a synonym of Metaphycus and with the three species group proposed by them. However, he replaced the name hederaceus-group with alberti-group, following Graham's (1958) opinion based on the study of the type species of Euaphycus.

Graham (1969) agreed with the species groups proposed by Compere & Annecke (1960) and, in view of the systematic position of hederaceus, suggested replacing the name hederaceus - group with asterolecannii - group. Excepting a few authors (Alam, 1957; Shafee et al., 1975) who described species under Euaphycus, most other authors regarded the species with 2-segmented maxillary and labial palps as forming a specis group within the genus Metaphycus (eg; Annecke & Mynhardt, 1971, 1972, 1981; Hayat & Subba Rao, 1981).

The Rules of the ICZN (1985) (Articles 41, 65b, 70a, b) state that if a genus-group name is based on a misidentified type species, then the case is to be referred to the Commission for a ruling. In the present case pertaining to Euaphycus, the Commission has not been approached for designation of another species as the type species of Euaphycus, apparently because all the species described under this name (except hederaceus) were considered as best placed in Metaphycus. It may also be noted that some authors (eg; Shafee et al 1975) continued to use the name Euaphycus as a valid taxon although neither hederaceus has been replaced by any other species as the type species of Euaphycus nor a new generic name proposed to withhold the concept of Euaphycus as defined by Mercet.

It, therefore, appears taxonomically sound to regard Euaphycus (Type species E. hederaceus Dalman) as a synonym of Aphycus as done by Noyes & Hayat (1984) and Hayat (1986), and to transfer to Metaphycus all other species included in

Euaphycus. The other course is to erect two new genus-group names, one for the species with 2-segmented maxillary and labial palps, the second genus for species with 3-segmented maxillary and labial palps, and to revalidate Mercetiella whose type species, reticulata (and Metaphycus intermedius (Mercet)) has the maxillary palps 3-segmented and labial 2-segmented. But this later course was not implemented even by those authors who, contrary to the Rules of the Nomenclature, continue to use Euaphycus as a valid taxon related to Metaphycus.

The present author agrees with Compere (1940) and others that the characters used by Mercet (1921, 1925) to separate Euaphycus from Metaphycus are largely unreliable. The only difference between these genera is in the number of segments of maxillary and labial palps. Other so-called distinguishing characters (body size, relative development of notaular lines) are quite variable sometimes even in a single species. The present author has found that even the well-developed notaular lines found in the species of zebratus-group are nothing but sculptural lines (i.e. a slight difference in sculpture) which appears as distinct, sometimes dark, lines in carded as well as in slide mounted specimens (Compare SEM photograph, Figs. 7,8 with camera lucida drawing Fig. 26).

**Classification:**

There are two basic systems of classification of Encyrtidae. One in which the family is divided into three subfamilies, Arrhenophaginae, Antheminae, and Encyrtinae, the last named subfamily further divided into three tribes, Encyrtini, Tetracnemini (= Ectromini sensu Ashmead; Anagyrini Hoffer) and Bothriothoracini (=Mirini sensu Ashmead). This system was followed, among others, by Compere & Annecke (1960) Tachikawa (1963), Kerrich (1967), Hayat et al (1975) and Shafee et al (1975). A slight modification of this system, adopted by Mercet (1921), Erdos & Novicky (1955), Hoffer (1955) Ferriere (1953) and De Santis (1964), recognises several (instead of the three) tribes or genus-groups in the Encyrtinae. The second system is that proposed by Trjapitzin (1973a) and followed by several recent authors including Trjapitzin & Gordh (1978a,b), Noyes & Hayat (1984), Myartseva (1984), Hayat (1985), and Noyes (1988). In this system the family is divided into two subfamilies, Tetracneminae and Encyrtinae, and each one of these subfamilies into several tribes and subtribes. The placment of the genera Aphycus and Metaphycus in the above mentioned systems of classification is discussed below.

In both the systems of classification Aphycus and Metaphycus (together with several related genera) are placed either in the Tribe Aphycini of subfamily Encyrtinae (Trjapitzin,

1973a; Hoffer, 1955; Noyes & Hayat, 1984; and others) or in Aphycus-group (Mercet 1921). However, Compere & Annecke (1960) have stated that in any natural classification of these two genra, Aphycus should be placed in the tribe Tetracnemini (= Ectromini sensu Ashmead) of Encyrtinae, which is equivalent to the subfamily Tetracneminae sensu Trjapitzin, and the genus Metaphycus be placed in Bothriothoracini (= Mirini sensu Ashmead) which is equivalent to Encyrtinae sensu Trapitzin. This proposal was accepted by Tachikawa (1963) and Kerrich (1967). At a first glance this placement of Aphycus in Tetracnemini (Tetracneminae sensu Trjapitzin) and Metaphycus in Bothriothoracini (Encyrtinae sensu Trjapitzin) appears correct. However, a closer study reveals that there are three characters that indicate that Aphycus was correctly placed in Encyrtinae sensu Trjapitzin (presence of differentiated margins of linea calva of fore wing, presence of filum spinosum of fore wing (Fig. 13) and third valvulae distinct and articulated with second valvifers (Fig. 10). The genera of the subfamily Tetracneminae are characterized by undifferentiated margins of linea calva without filum spinosum and third vulvulae and second valvifers forming a continuous valvula (i.e. third valvla not differentiated from second valvifers). The triangular hypopygium reaching to the apex of the gaster in Aphycus can not, however, be taken as a character for placing it in Tetracneminae, as there are some species (of subgenus Aphycaspis Hoffer) in which the

hypopygium is rectangular and barely reaches to about four-fifth length along gaster. Therefore it seems correct to place Aphycus in Encyrtinae.

The genus Metaphycus is placed in a subtribe Paraphycina of the tribe Aphycini that also includes Aphycus and related genera.

However, the present author feels that the following characters of Metaphycus and related genera of Paraphycina indicate that it must be removed from the tribe Aphycini, and placed in the tribe Microteryini.

**Characters of Aphycus and related genera:**

1. Mandible sharply 3-dentate with dorsal tooth usually receding (Fig. 14).
2. Fore wing with linea calva uninterrupted and with basal triangle bare (Fig. 13).
3. Targum VII of gaster large, nearly subrectangular (Fig. 11).
4. Hypopygium usually prominent, reaching or nearly reaching apex of gaster (Fig. 10).
5. Antennae unicolourous, pale.
6. Legs long and slender with long tarsi.

These characters indicate that the tribe Aphycini is very close to Homalotylini.

**Metaphycus and related genera:**

1. Mandible 3-dentate, the dorsal tooth, if pointed, not receding (Fig. 5).
2. Fore wing with linea calva interrupted and disc setose to base, without triangular bare area (Fig. 4).
3. Tergum VII of gaster convexly rounded (Fig. 17).
4. Hypopygium extending at most to four-fifth length of gaster (Fig. 16).
5. Antennae usually diversicoloured (Figs. 22,24).
6. Legs short, robust with shorter tarsi.

These characters indicate that Metaphycus and related genera are better placed in the tribe Microteryini.

**Species Group :**

The genus Metaphycus, as noted above, is separated into three species groups (zebratus-group; insidiosus-group; asterolecanii-group) only on the basis of the number of segments in the maxillary and labial palps, and without considerations of other characters. That such a division would be unnatural has already been pointed out by Compere (1940). He has shown that there are several species which are very similar in their

morphology, except for the number of segments in the palps. But so far no attempt has been made to study the relationships of the species of the genus. Until such a study is conducted*, the present author considers it desirable to continue to recognize the three groups of species solely for convenience, since even for species which are otherwise very closely related, the only distinguishing character ultimately remains the number of segments in the palps.

**Zoogeographical distribution:** The genus Metaphycus is cosmopolitan in distribution. It contains 220 species. The genus appears to be mainly an old world genus with the Afrotropical region containing the greatest number of species (83), followed by the Palaearctic region with 75 species. The Australian region (including the Pacific ocean islands) has 28 species. The genus is rather poorly represented in the Nearctic, Neotropical and Oriental regions (Table 1).

**Table 1.** Zoogeographical distribution of Metaphycus species (The number of species known from more than one region is noted in parenthesis).

| S.No. | Zoogeographical region | Number of species |
|---|---|---|
| 1. | Oriental | 12(6) |
| 2. | Afrotropical | 77(6) |
| 3. | Palaearctic | 65(10) |
| 4. | Australian (including Pacific islands) | 20(8) |
| 5. | Nearctic | 19(15) |
| 6. | Neotropical | 10(9) |

* As only 15 species are known from India out of a total of 220 world species, the author does not consider it possible

**Biology:** The species of Metaphycus, so far as their biology is known, are all endoparasitoids of scale insects (Coccoidea) belonging to the Coccidae, Eriococcidae and Asterolecaniidae. Some species are also recorded as parasitoids of the armoured scales (Diaspididae) and mealybugs (Pseudococcidae), but these records are probably erroneous. Of the 220 species, hosts are known for 141 species.

**Use in biocontrol :** Several species of Metaphycus were used in the control of soft scale insects injurious to fruit trees. Among the introduction of Metaphycus species from one country into another may be mentioned the following cases where considerable success has been achieved.

M. lounsburyi (Howard) was introduced into the States, Australia, Israel and several other west European countries for control of Saissetia oleae. (DeBach, 1964). M. helvolus (Compere) was introduced for southern Africa into several countries, and was successful in controlling soft scale pests of fruit trees (Annecke & Mynhardt, 1981). Similar successes were also recorded for M. flavus introduced from the States into several countries in S. America and Europe.

**Key to Indian species of Metaphycus, females.**

1. Maxillary palps 4-segmented, labial palps 3-segmented (Fig. 20) ..... zebratus-group....3

- Maxillary palps 2-or 3-segmented, labial palps 2- or 3-segmented. ....2

2. Maxillary and labial palps each 3-segmented (Fig. 19) ..... insidiosus-group....6

- Maxillary and labial palps each 2-segmented (Fig. 5) ..... asterolecanii-group....8

3. Ovipositor subequal in length to or at most a sixth longer than middle tibia, and third valvula distinctly shorter than middle tibial spur (at most 4: 6) (Figs.27,28)....4

- Ovipositor 1.3 - 1.5X as long as middle tibia and third valvula as long as or a little shorter than middle tibial spur (Figs. 32, 33) .....5

4. Fore wing shortened, not reaching apex of gaster (Fig. 23); infuscation of scape as in Fig. 22, F1-4 brown ..... ..... 1. brevielus Kaul & Agarwal

- Fore wing normally developed, reaching past apex of gaster (Fig. 4); infuscation of scape as in Figs. 24,25, at most only F1 and F2 completely or partly dark brown..... 2.zebratus (Mercet)

5. Scape about 2X as long as wide, infuscate dark brown with base and apex white..... 3. lichtensiae (Howard)

- Scape nearly 3X as long as wide, with infuscation as in Figs. 24,25 ..... 4. maculatus Agarwal.

6. Scape narrow, about 4X as long as wide; frontovertex 1.5 - 2X as long as wide; F1-5 nearly subequal, smaller, F6 slightly larger; scape with a small brown spot on outer surface near apex ..... 5.flavus (Howard)

- Scape expanded below, not more than 3X as long as wide; frontovertex narrow, at least 2.5X as long as wide, at most F1-4 subequal in length and width, and smaller than F5 and F6, scape largely dark brown with base, apex and dorsal margin white .....7

7. Scape 2-2.3X as long as wide with white areas relatively large (Fig. 34), radicle white; F1-4 smaller than F5 and F6; F5 and F6 with longitudinal sensilla; ovipositor shorter than middle tibia and third valvula shorter than middle tibial spur (Figs. 36, 37) ..... ..... 6. indicus Shafee et al.

- Scape at most 1.75X long as wide with the white areas small (Fig. 40), radicle dark brown; F1 and F2 smaller than F3; F3 and F4 smaller than F5; F3-6 with longitudinal sensilla, ovipositor distinctly longer than middle tibia and third valvula longer than middle tibial spur (Figs. 41, 42)..... 7. latiscapus Alam

8. *Funicle segments all with longitudinal sensilla, the segments* quadrate to slightly longer than broad, pedicel shorter than F1 and F2 combined; scape less expanded, at

least slightly more than 3X as long as wide; clava shorter than preceding four funicle segments combined (Fig. 43)..... 8. fuscidorsum (Gahan)

9. crotolariae (Shafee et al)

- At most F5 and F6 with longitudinal sensilla; funicle segments usually broader than long; or F1-4 each conspicuously smaller than F6, pedicel longer than F1 and F2 combined; scape at most 3X as long as wide; clava longer than preceding four funicle segments combined.....9

9. Scape about 2X as long as wide, largely dark brown with base, apex and dorsal margin white; frontovertex 2.5X as long as wide. (F6 distinctly larger than F5, F1-5 nearly subequal in length and width; F1-3 and basal two segments of clava dark brown).....
..... 10. agarwali Hayat & Subba Rao.

- Scape more than 2X as long as wide, with white areas larger than in the above species; frontovertex 2X as long as wide or less .....10

10. F5 and F6 with longitudinal sensilla and F5 longer than F6; frontovertex, at level of front ocellus, about one-third of head width..... 11. cerococci (Shafee et al).

- Only F6 with longitudinal sensilla; F5 never larger or longer than F6; frontovertex (except in smaller specimens), less than one-third of head width .....11

11. Radicle pale brown to dark brown (Fig. 51).....12

- Radicle white (Fig. 55) (Frontovertex nearly 2X as long as wide; body largely pale with minimum of brown markings. Male antenna with funicle segments broader than long and with pale setae (Fig. 59)..... .....12. gilvus Compere

12. Radicle pale brown; frontovertex 1.5X as long as wide; ocelli arranged in an equilateral triangle. (Male antenna with funicle segments quadrate, F6 longer than F5, and flagellar segments with conspicuously long setae).....13. helvolus (Compere)

- Radicle brown to dark brown, frontovertex in larger specimens more than 1.5X, but less than 2X as long as wide; ocellar triangle with apex acute. (Male antenna with funicle segments broader than long and with relatively shorter, pale setae Fig. 54)..... ..... 14. longiclavatus (Shafee et al).

## 1. Metaphycus brevielus Kaul & Agarwal

**(Figs. 22, 23)**

Metaphycus brevielus Kaul & Agarwal, 1985: 29. Female. India, unknown locality (Zool. Dept. A.M.U.).

**Diagnosis :**

Female-Brachypterous; head width 4X as wide as frontovertex width; frontovertex nearly 3X as long as wide; ocellar triangle with apical angle acute, lateral ocelli almost touching eye margin and removed from occipital margin by a distance slightly more than the major diameter of an ocellus. Antennal scape about 3X as long as wide; F1-4 small, subequal in length; F5 and F6 large with sensilla (Fig. 22). Mesoscutum transverse, 2.25X as wide as long, shorter than scutellum (12: 17) and with nearly complete notaular lines. Wings small; fore wing as in fig. 23; hind wing much smaller than fore wing (27: 40). Gaster subtriangular, slightly shorter than thorax; ovipositor 4.6X as long as third valvula and slightly longer than middle tibia (23.5: 20) and hind tibia (23.5: 20.5).

Body colour generally pale yellow with occiput above foramen, centre of pronotum and a dot on each postero-lateral corner of collar of pronotum brown; propodeum mesad of spiracles and dorsum of gaster suffused with brown.

Antenna (Fig. 22) pale yellow, radicle, a patch on scape, proximal two-third of pedicel, F1-4, and clava brown to dark brown. Legs pallid, with two faint brown incomplete rings on middle tibia, and one ring on hind tibia.

Male - unknown.

**Host** : unknown

**Distribution**: India (No locality given in the original description).

**Material examined** :

Holotype female (dissected and mounted on a single slide) and 1 female paratype on a card. The types with the data as given in the original description.

**Comments** :

This is the only brachypterous species known from India. The other brachypterous species of zebratus- group, M. bulgariensis Sugonjaev (1976), differs from brevielus in the following characters: ocelli in equilateral triangle; scape slightly more than 2X as long as wide, F3 and F4 each about 2X as wide as long; mesoscutum slightly more than 1.5X as wide as long and as long as scutellum, and ovipositor as long as hind tibia.

## 2. Metaphycus zebratus (Mercet)

**(Figs. 1-4,8,15,17,21,24,27)**

Aphycus (Metaphycus) zebratus Mercet, 1917: 138. Female. Spain, Cercedilla (Madrid Museum).

Mercet, 1921: 222. Female, male. Mani, 1989: 849.

Metaphycus zebratus (Mercet) : Shafee et al., 1975: 81. Hayat & Subba Rao, 1981: 116. Noyes & Hayat, 1984: 298. Hayat, 1986: 112.

**Diagnosis :**

Female - Frontovertex one-fifth to slightly less than one-fifth of head width and 2.75-3X as long as wide; ocellar triangle acute (Fig. 1,2). Scape slightly more than 2X to 2.5X as long as wide; F1-4 subequal; F5 longer than F6, both with longitudinal sensilla (Fig. 3,24,25). Mesoscutum (Fig. 26) with nearly complete notaular lines. Fore wing with lines calva interrupted by 2-3 lines of setae (Fig. 4). Ovipositor only slightly longer than or subequal in length to middle tibia; third valvula about one-fifth the length of second valvifers, and distinctly shorter than middle tibial spur (Figs. 27,28).

Body yellow to pale yellow, with occiput above foramen, mouth margin, a larger patch on pronotum,

anterior margin of mesoscutum, notaular lines, sides of metanotum, propodeum mesad of spiracles, and dorsum of gaster largely, brown to dark brown. Radicle, scape with a band on outer surface above, and larger patch or band on inner surface on the expanded part (Figs. 24, 25), basal one third to two-third of pedicel, F1-2 usually incompletely, and nearly whole of clava brown to dark brown, rest white. Fore wing with a faint infuscation in middle. Legs yellow, with two bands on all tibiae.

Male - Similar to female except as follows: head about 3.5X of frontovertex width; frontovertex about 2X as long as wide; scape narrow, about 3X as long as wide, and with a dark streak in upper third (Fig. 29).

**Hosts:** Ceroplastodes cajani (Maskell); (?) Aonidiella orientalis (Newstead); (?) Nipaecoccus sp.

**Distribution:**

India: Himachal pradesh, Punjab, Uttar Pradesh (Palaearctic).

**Material examined:**

India: Uttar Pradesh, Aligarh, 1F (= female) ix, 1980; 1F, 26.iv. 1985; 1F iv. 1981; 1M (= male), 28.iv.1985,

1M 3.x.1984; Narora, 1F 17.xii.1979. In addition, the author has also examined 3 females, one each from Manali, Phillaur and Aligarh listed by Shafee et al (1975) and present in Hayat collection.

**Comments:**

Noyes (1981) stated that the type material was probably lost and the specimen of this species located in the Madrid Museum was labelled "Paraphycus zebratus. Madrid 12-VII. 1912" whereas the type locality given by Mercet (1919) was Cercedilla. The material listed above and part of that reported upon by Shafee et al (1975) agrees well with the original description. The species differs from other species of zebratus-group by having a narrow frontovertex, only F1 and F2 completely or partly dark brown and relatively shorter ovipositor. It differs from brevielus by having normally developed wings.

### 3. Metaphycus lichtensiae (Howard)

Aphycus lichtensiae Howard, in Howard and Ashmead, 1896: 640. Female. Sri Lanka, Pundaluoya (U.S. National Museum, Washington D.C.)

Ayyar, 1925: 295. Mani, 1938: 90, Mani, 1989: 893 (in subgenus Aphycus).

Metaphycus lichtensiae (Howard): Compere & Annecke, 1960: 385. Annecke & Mynhardt, 1971: 356. Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 112. Srinivasa, 1987: 122.

**Diagnosis:**

Female - Frontovertex 3X as long as wide, ocellar triangle with apical angle strongly acute. Scape about 2X as long as wide, F1-4 smaller, F5 slightly larger than F6. Fore wing with linea calva interrupted by three lines of setae. Ovipositor about 1.3X as long as middle tibia, third valvula slightly shorter than middle tibial spur.

Head orange yellow, with occiput, malar space below and mouth margin, blackish; centre of pronotum, anterior margin of mesoscutum, notaular lines, metanotum, propodeum mesad of spiracles, and dorsum of gaster, dark brown to black. Scape colour about as in zebratus (as in Fig. 24); basal half of pedicel, F1-4 brownish, clava black. Wings hyaline. Legs yellow, with all tibiae with two brownish bands.

Male - Frontovertex about 2X as long as wide. Scape about 3X as long as wide. Colour about as in female;

the scape with both dorsal and ventral margins blackish.

**Hosts:** Chloropulvinaria psidii (Maskell), Coccus viridis (Green); Parasaissetia nigra (Nietner); Saissetia oleae (Olivier).

**Distribution:**

India: Karnataka (Sri Lanka; Pakistan).

**Comments:**

The author has not seen specimens of this species The diagnosis given above is based on the redescriptions given by Timberlake (1916), Compere & Annecke (1961) and Annecke & Mynhardt (1971), the later two redescriptions based on Indian material.

This species appears to be very distinctive and can be separated from all the other Indian species by the characters given in the key.

### 4. Metaphycus maculatus Agarwal

**(Figs.20,30-33)**

Metaphycus maculatus Agarwal, 1965: 89. Female, male. India, Aligarh (Zoology Dept. AMU, Aligarh).

Shafee et al., 1975: 80. Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 112. Srinivasa, 1987: 122.

Aphycus (Metaphycus) maculatus (Agarwal): Mani, 1989: 847.

**Diagnosis:**

Female- Frontovertex slightly more than one-fifth of head width, ocellar triangle acute. Scape slightly less than 3X as long as wide, F1 quadrate, F2-4 very slightly increasing in width distad, shorter than F5; F5 longer than F6 and both with longitudinal sensilla (Fig. 30) Mesoscutum with nearly complete notaular lines. Linea calva of fore wing (Fig. 31) interrupted by about 4 lines of setae. Ovipositor 1.3X as long as middle tibia, third valvula about one-fourth the length of second valvifers, subequal in length to middle tibial spur which is distinctly shorter than middle basitarsus (Fig. 32, 33).

Body largely yellow to pale orange yellow, with occiput above foramen, mouth margin narrowly, a large patch in centre of pronotum, anterior margin of mesoscutum sides of metanotum, propodeum mesad of spiracles, and dorsum of gaster brown to dark brown. Radicle, scape as in fig. 30, more than basal half of pedicel, F1-4 and clava dark brown. Wings hyaline. Legs yellow, with middle and hind tibiae each with two dark bands.

Male - Similar to female, except scape less expanded with dark brown bands along upper third and lower third, and clava unsegmented.

**Hosts:** Coccus viridis (Green); Ceroplastes sp.; Eriococcus lagerstromiae Kuwana; Pulvinaria sp.; Saissetia coffeae (Walker).

**Distribution:**

India: Karnataka, Maharashtra, Rajasthan, Uttar Pradesh.

**Material examined:**

Holotype female and a female and male paratypes dissected and mounted on 3 slides, with data as given in the original description (Agarwal, 1965).

INDIA: Himachal Pradesh, Manali 1F, 9.x.1979 (M. Hayat).

**Comments:**

This is a very distinctive species of zebratus group. It differ from all the other species in the shape and infuscation of scape, longer ovipositor and dark colour of radicle. These characters separate it from lounsburyi. Also the antenna in males is distinct in having two brown bands on scape and F1-4 brown, each distinctly shorter than F5. M. citricola Annecke & Mynhardt (1971) originally described from South Africa and later recorded also from Pakistan (ex Saissetia privigna (see Hayat &

Subba Rao, 1981) appears to be indistinguishable and may eventually prove to be a synonym of maculatus.

### 5. Metaphycus flavus (Howard)

Aphycus flavus Howard, 1881: 365. Female, USA (U.S. National Museum, Wahsington, D.C.).

Ayyar 1927: 73-78. Mani, 1938: 91. Pruthi & Mani, 1940: 15. Kaul & Saraswat, 1974: 189. Mani, 1989: 839 (In subgenus Aphycus).

Metaphycus flavus (Howard): Compere & Annecke, 1960: 385. Annecke & Mynhardt, 1972: 27, Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298.Hayat,1986: 111.

**Diagnosis:**

Female - Frontovertex 1.5-2X as long as wide, ocellar triangle with apical angle acute . Scape narrow, about 4X as long as wide, F1-5 gradually increasing in width distad, F6 larger. Fore wing with linea calva interrupted by three lines of setae. Ovipositor slightly longer than middle tibia and third valvula about equal in length to middle tibial spur.

Body largely yellow with centre of pronotum, propodeum and dorsum of gaster sometimes slightly brownish. Wings hyaline. Legs yellow. Antenna pale, scape with a small spot in distal half, F1-2 and F3 partly and basal two segments of clava dark brown.

Male - Similar to female; antenna as in gilvus (as in fig. 59).

**Host :** Pulvinaria maxima Green, Indet, scales.

**Distribution :**

India: Himachal Pradesh, Tamil Nadu, (Lebanon, Brazil, Chile, Peru, Greece, USA, Hawaian Island, Israel, Egypt, France, Portugal, Tunisia, South America, Carribian Islands, Madeira, Canary Is., Paraguay, Puerto Rico, Lesser Antiles, Introduced in Spain, Morocco & Burmuda).

**Comments:**

The author has not seen any specimens of this species. The diagnosis given above is based on the notes provided by Timberlake (1916), Compere (1940, 1957) and Annecke & Mynhardt (1972). It differs from all the other Indian species of insidiosus - group by the narrow antennal scape, broader frontovertex and in

having F1-5 smaller, subequal in length, and the scape with a small brown spot on outer surface near apex.

### 6. Metaphycus indicus Shafee, Alam & Agarwal (Figs. 34-37)

Metaphycus indicus Shafee, Alam & Agarwal, 1975: 79. Female, male. India, Bucchireddipalem (Zool. Dept. A.M.U., Aligarh).

Hayat & Subba Rao, 1981: 115, Noyes & Hayat, 1984: 298. Hayat, 1986: 112.

Aphycus (Metaphycus) indicus (Shafee et al): Mani, 1989: 846.

**Diagnosis:**

Female- Frontovertex narrow, slightly less than one-fifth of head width; ocellar triangle strongly acute. Scape 2-2.3X as long as wide, F1-4 nearly subequal in length, F5 longer than F6 and both with longitudinal sensilla. Mesoscutum with incomplete notaular lines. Fore wing with linea calva interrupted by about four lines of setae (Fig. 35). Ovipositor slightly shorter than middle tibia, and third valvula one-quarter as long as second valvifer and about half the length of middle basitarsus (Figs. 36, 37).

Body white to pale yellow, with occiput, centre of pronotum and dorsum of gaster brown. Radicle white, scape except base, apex and dorsal margin, basal half or so of pedicel, F1-4 and basal segment of clava dark brown, the patch on outer face of scape smaller than that on its inner surface. Wings hyaline. Legs immaculate.

Male - Described by Shafee et al (1975) as being similar to female. Antenna, as can be judged from the description, should be about as in gilvus (as in Fig. 59).

**Host :** Pulvinaria sp.

**Distribution :**

India: Andhra Pradesh, Uttar Pradesh (new record).

**Material examined:**

INDIA: Uttar Pradesh, Dehradun, 1F,11.iv. 1978 (M. Verma).

**Comments:**

The above listed specimen agrees fairly well with the original description of M. indicus. This species is extremely close to the Taiwanese species M. angustifrons

Compere (1957) and may eventually prove to be a synonym of Compere's species. The single female listed above and the original description given for indicus agree well with the description given for angustifrons and additional notes and illustrations given by Annecke & Mynhardt (1972).

### 7. Metaphycus latiscapus Alam

### (Figs. 19, 38-42).

Metaphycus latiscapus Alam, 1972: 134. Female, male. India, Uttar Pradesh (Zool. Dept. A.M.U. Aligarh).

Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 112.

**Diagnosis:**

Female - Frontovertex about one-fifth of head width (Fig. 38); ocellar triangle strongly acute. Scape about 1.75X as long as wide, F1 & F2 subequal, each smaller than F3; F3 & F4 subequal, and each a little smaller than F5 which is subequal to F6; F3-6 with longitudinal sensilla. Mesoscutum with incomplete notaular lines. Fore wing with linea calva interrupted by 3-4 lines of setae. Gaster slightly shorter than thorax; ovipositor longer than middle

tibia (33-39, 21-26), third valvula slightly more than one third of second valvifer (9-10: 24-29) and subequal in length to middle basitarsus (Fig. 41,42).

Body generally yellow, with occiput above foramen, a patch in centre of pronotum, anterior margin of mesoscutum, metanotum on sides, propodeum mesad of spiracles and most of dorsum of gaster brown to dark brown. Radicle, scape largely (except white base apex and dorsal margin narrowly) basal two-third of pedicel and first segment of clava dark brown, F1-4 brown. Wings hyaline. Legs pale yellow, with base and a ring at proximal third of middle and hind tibiae brown.

Male - Similar to female except for uniformly brown funicle (Alam, 1972, Fig. 4).

**Host:** (?) Aonidiella orientalis (Newstead)

**Distribution:**

India: Uttar Pradesh.

**Material examined:**

Holotype female, and 1F, 1M paratypes with the same data as given in the original description (Alam, (1972)).

INDIA: Uttar Pradesh, Aligarh, 1F, 18.xi.1979, 1F; 4.i.1980, 1F, 10.iii.1985.

**Comments:**

M. latiscapus differs from all described species of the genus in having greatly enlarged scape (less than 2X as long as wide) F3-6 with longitudinal sensilla, smaller clava, and in the male by the enlarged scape.

### 8. Metaphycus fuscidorsum (Gahan)

Aphycus fuscidorsum Gahan, 1919: 521. Female. India, Coimbatore (U.S. National Museum, Washington D.C. ).

Ayyar 1925: 295. Mani 1938: 89. Pruthi & Mani, 1940: 15. Hayat & Subba Rao, 1981: 108 (as fusidorsum!) Mani, 1989: 838 (in subgenus Aphycus).

Metaphycus fuscidorsum (Gahan): Noyes & Hayat, 1984: 298. Hayat, 1986: 111 (as fusidorsum!).

**Hosts :** Ceroplastodes cajani (Maskell); scales on Lab-Lab.

**Distribution:**

India: Tamil Nadu.

**Comments:**

This species, as already noted by Hayat & Subba Rao (1981) and Noyes & Hayat (1984), might be a senior synonym of M. crotolariae (see comments given under crotolariae).

## 9. Metaphycus crotolariae (Shafee, Alam & Agarwal)

## (Figs. 6,9,16,18,43-47)

Euaphycus crotolariae Shafee, Alam & Agarwal, 1975: 85. Female, male. India, Mangalagiri (Zool. Dept. A.M.U. Aligarh).

Metaphycus crotolariae (Shafee et al): Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 111.

Aphycus (Euaphycus) crotolariae (Shafee et al): Mani, 1989: 844.

**Diagnosis:**

Female - Frontovertex about one-fourth of head width and slightly less than 2X as long as wide; ocellar triangle acute. Scape about 3X as long as wide (If slightly tilted than it appears 3.5X as long as wide)), pedicel shorter than F1 and F2 combined; all funicle segment quadrate to slightly longer than wide (Fig. 43). Linea calva of fore wing interrupted by 2-4 lines of setae (Fig. 44). Ovipositor slightly shorter than middle tibia, third valvula about one-fourth the length of second valvifer and slightly longer than half the length of middle tibial spur (Figs. 45, 46).

Body generally yellow to pale yellow brown, with occiput above foramen, centre of pronotum, anterior margin of mesoscutum, metanotum on sides, propodeum mesad of spiracles and dorsum of gaster brown to dark brown. Radicle at least partly, a patch each on outer and inner surface of scape, basal two-third of pedicel, F1-4 and basal two segments of clava dark brown, F5 and F6 pale brown. Wings hyaline. Legs yellow, with two incomplete brown bands each on all tibiae.

Male - Similar to female except for a still slender scape, uniformly coloured brown flagellum (Fig. 47) and broader frontovertex (about one-third of head width).

**Hosts:** Cerococcus indicus (Maskell); Ceroplastodes sp. C. cajani (Maskell)

**Distribution:**

India: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Maharashtra.

**Material examined:**

INDIA: Karnataka, Banglore, 2F, 1M, 8.xiii.1982, CIBC. 317a ex Cerococcus indicus on Hyptis suaveolem, (det. M. Hayat); Tamil Nadu, Sri Rangam, 1M,27.ii.1967, ex Ceroplastodes sp., Maharashtra, Manmad, 1F, x. 1967. ex coccid on pupalia lappacea, (M. Hayat), Nagpur (Khapri) 20F, 3M, ix 1970, ex Ceroplastodes sp. (M. Hayat).

**Comments:**

This is a very distinctive species and differs from all the known species (except M. eurhinus Annecke & Mynhardt, 1981, which has a very slender scape, ovipositor longer than middle tibia, and broader funicle segments in male) in having quadrate to slightly longer than wide funicle segments in both sexes, and presence of longitudinal sensilla on all segments of funicle. It is doubtfully distinct from another Indian species, M. fuscidorsum (Gahan), and as noted by Noyes & Hayat (1984), may eventually prove to be a synonym of Gahan's spcies.

### 10. Metaphycus agarwali Hayat & Subba Rao

Euaphycus latiscapus Shafee, Alam & Agarwal, 1975: 84. Female. India, Patna (Zool. Dept. A.M.U. Aligarh) Preoccupied in Metaphycus by latiscapus Alam.

Metaphycus agarwali Hayat & Subba Rao, 1981: 115. Replacement name for latiscapus Shafe et al.

Noyes & Hayat, 1984: 298. Hayat, 1986: 111.

Aphycus (Euaphycus) latiscapus (Shafee et al): Mani, 1989: 842.

**Diagnosis:**

Female - Frontovertex about 2.5X as long as wide, ocellar triangle with apical angle acute. Scape slightly less

than 2X as long as wide; F1-5 subequal, only slightly increasing in width distad; F6 large.

Body yellow with dorsum of thorax and gaster brown. Radicle, scape except narrowly at base, apex and dorsal margin, proximal two-third of pedicel, F1-3 and basal two segments of clava dark brown, rest white. Legs yellowish white with two dark bands on middle tibiae.

Male - Unknown

**Host:** Pulvinaria maxima Green .

**Distribution:**

India: Bihar.

**Comments:**

Types of this species were not seen. The above diagnosis is based on the original description given by Shafee et al (1975). The species appears to be distinct especially by the larger scape, and general body colour.

### 11. Metaphycus cerococci (Shafee, Alam & Agarwal)

Euaphycus cerococci Shafee, Alam & Agarwal, 1975: 83. Female, male. India, Banglore (Zool. Dept. A.M.U. Aligarh).

Metaphycus cerococci (Shafee et al); Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 111.

Aphycus (Euaphycus)cerococci (Shafee et al): Mani, 1989: 844.

**Diagnosis:**

Female - Frontovertex broad, nearly one-third of head width; ocellar triangle equilateral. Scape nearly 3X as long as wide; F1 slightly longer than broad, F2-5 quadrate, F5 longer than F6, and both with longitudinal sensilla. Ovipositor slightly shorter than middle tibia; third valvula slightly more than half the length of middle tibial spur which is nearly subequal to middle basitarsus.

Body mainly yellow, with malar space narrowly along ventral margin, occiput, a large patch in centre of pronotum, brown. Radicle white; scape except basal third and apical fifth, pedicel except apical fourth, F1-4 and clava dark brown. Wings hyaline. Legs yellow.

Male-antenna appears similar to that of M. gilvus (as in fig. 59).

**Host:** Cerococcus hibisci (Maskell)

**Distribution:**

India: Karnataka.

**Material examined:**

Holotype female (in alcohol) with the data as given in the original description (Shafee et al, 1975).

**Comments:**

No further material of this species was collected. It is included in the key on the basis of the original description and illustrations, and on the study of the holotype female.

M. cerococci appears to be a distinct species among the asterolecanii - group of species. It is closely related to aurantiacus Annecke & Mynhardt (1981) in the antennal dimensions and relative lengths of ovipositor and middle tibia. (M. aurantiacus has a narrow frontovertex, about 0.20 of head width), and amblydentis Annecke & Mynhardt (1981) in having similar head dimensions. M. ambyldents differs from M. cerococci in having F1-4 transverse and ovipositor longer than middle tibia.

## 12. Metaphycus gilvus Compere

**(Figs. 55-59)**

Metaphycus gilvus Compere, 1957: 223 Female, male. Eritrea. Annecke & Mynhardt, 1981: 62.

**Diagnosis:**

Female-Head about 3.5X to nearly 4X of frontovertex width; frontovertex nearly 2X as long as wide; ocellar triangle slightly acute. Scape about 2.5X as long as wide; F1-4 subequal, small; F5 and F6 larger, F5 slightly smaller than F6 (Fig. 55). Linea calva of fore wing interrupted by 3-4 lines of setae (Fig. 56). Ovipositor subequal in length to only a trifle longer than, middle tibia; third valvula one-fifth to one-fourth the length of second valvifer and slightly more than half the length of middle tibial spur (Figs. 57, 58).

Body pale yellow to nearly whitish, rarely yellow, occiput above foramen sometimes pale brown; the patch in centre of pronotum small and pale brown. Radicle, usually F4-6 and distal two segments of clava white, scape with a patch, basal half or less of pedicel, F1-3 and first segment of clava brown to dark brown. Wings hyaline. Legs immaculate.

Male - Similar to female, except for the antenna (Fig. 59), and relatively darker body colour.

**Hosts:** Pulvinaria maxima Green ; Ceroplastes sp. indet coccids.

**Distribution:**

India: Uttar Pradesh, Madhya Pradesh (South Africa, Eritrea, U.S.A. in lab).

**Material examined:**

INDIA: Uttar Pradesh, Aligarh, 2F, 1M, vii 1967, ex Pulvinaria maxima, (M. Hayat); 3F, 3M, vii. 1968.ex Ceroplastes sp. on Mangifera indica, (M. Hayat); Hardoi, 1F, xi. 1969, ex indet. coccids on M. indica, (M. Hayat); Madhya Pradesh, Ujjain, 27F, 14M, ii 1971, ex indet coccids (Shujauddin).

**Comments:**

M. gilvus is recorded here for the first time from India, though it is very likely that either longiclavatus or malabarensis or mostly likely both may eventually prove to be its synonyms. The only difference between gilvus and longiclavatus appears to be the colour of the radicle; pale in gilvus and brown to dark brown in longiclavatus. The antenna in the males of the two species are quite similar (Figs. 54, 59) (see also notes given under helvolus and longiclavatus).

## 13. Metaphycus helvolus (Compere)

Aphycus helvolus Compere, 1926: 25. Female. South Africa, Cape province (U.S. National Museum, Washington D.C.).

Metaphycus helvolus (Compere): Compere, 1940: 29. Annecke & Mynhardt 1981: 42. Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat, 1986: 111. Srinivasa, 1987: 1987: 122.

**Host:** Coccus viridis (Green)

**Distributions :**

India: Karnataka (South Africa, Bangladesh, Pakistan , Australia, Argentina, Equador, Peru, Chile, France, S.W. Africa, Israel, Greece, Iran, Italy, U.S.A. introduced).

**Comments:**

This is a well known, widely distributed Afrotropical species and has been introduced into the States (see Annecke & Mynhardt, 1981). It was recorded from India by Srinivasa (1987). The present author has not seen any material of this species.

M. helvolus is indistinguishable from a complex of species (such as praevidens (Silvestri), aethiopicus Compere, gilvus Compere, dispar (Mercet), tamakatakaigara

(Tachikawa) which are more or less similar in the female sex, but differs from all these species in having the male antennae with quardrate funicle segments and flagellum with long setae. In the absence of males it is impossible to identify this species accurately.

**14. Metaphycus longiclavatus (Shafee, Alam & Agarwal) (Figs.5, 48-54)**

Euaphycus longiclavatus Shafee, Alam & Agarwal; 1975: 88. Female. India, Aligarh (Zool. Dept. A.M.U. Aligarh).

Metaphycus longiclavatus (Shafee et al): Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1989: 298. Hayat, 1986: 112.

Aphycus (Euaphycus) longiclavatus (Shafee et al): Mani, 1989: 842.

**Diagnosis:**

The diagnosis given for M. gilvus applies also to this species except that smaller specimens (about 0.7 - 0.8 mm) have relatively narrow scape (Fig. 48), broad frontovertex (about one-third of head width which is 1.5X as long as wide), and brown to dark brown radicle (Fig. 47).

**Hosts:** Chloropulvinaria polygonata (Cockerell); Chloropulvinaria sp.; Ceroplastodes cajani (Maskell); Paralecanium sp. near coccophyllae sp.

**Distribution:**

India: Uttar Pradesh, Karnataka, Punjab.

**Material examined:**

INDIA: Uttar Pradesh, Sasni near Aligarh, 9F, 4M, vii. 1968, ex Chloropulvinaria sp. on Dalbergia sisso, (M. Hayat); Aligarh, 3F, vii. 1968, ex. indet. coccids on D. sisso, (M. Hayat) 1F, 23. vi. 1984 (M. Hayat and S.S. Islam). Karnataka, Bangalore, 1F, 18.iv. 1982, ex C. polygonata (CIBC Coll.); 3F, 4M, 30. ix.1982, ex Paralecanium sp. near coccophyllae on Polyalthia leaf (CIBC Coll.) Punjab, Phillaur, 4F, 1M, 5. ix. 1968. ex Ceroplastodes cajani on Ficus sp. (M. Hayat). A paratype female from Hayat collection.

**Comments:**

M. longiclavatus is extremely close to M. gilvus and differs only in having a dark radicle, and a yellow body with the brown markings relatively more distinct. In these characters, longiclavatus females are indistinguishable from M. aethiopicus Compere (Compere 1940, 1957, Annecke & Mynhardt, 1981), but males are unknown in aethiopicus, hence it is not possible to be sure whether longiclavatus (whose males are similar to those of gilvus) is conspecific with gilvus or aethiopicus.

## 15. Metaphycus malabarensis (Mukerjee)

Aphycus malabarensis Mukerjee, in Saraswat & Mukerjee, 1975: 46, Female. India, Kasaragod (School of Ent., Agra).

Mani, 1989: 838 (In subgenus Aphycus)

Metaphycus malabarensis (Mukerjee): Hayat & Subba Rao, 1981: 115. Noyes & Hayat, 1984: 298. Hayat 1986: 112.

**Diagnosis:**

Female - Head width about 4X of frontovertex width. Scape about 3X as long as Wide. Linea calva of fore wing interrupted by about two lines of setae. Body yellowish; scape except base and apex, basal half of the Pedicel, F1-4 and first segment of clava brown to dark brown, remaining parts white.

Male - unknown

**Host** - unknown

**Distribution:**

India: Kerala.

**Comments:**

The above diagnosis is based on the original description. The segmentation of the palps was not given in the original description, and, therefore, the species is not included in the key. If the palps are 2-segmented, then, malabarensis might prove to be very close to gilvus.

## Conclusions

This preliminary study on the Indian species of Metaphycus leads the author to the following tentative conclusions on the systematics of the Indian species.

1. The number of known species from India probably does not represent more than a fraction of the actual number of species that should be present, but which await discovery. This statement is supported by the fact that out of several hundred species of scale insects, Metaphycus species were recorded so far from only 11 species (10 genera) of coccids. Therefore, more intensive surveys of the fruit growing regions in India are likely to yield several, possibly undescribed, species of Metaphycus.

2. Out of the 15 known species, four may eventually prove to be invalid synonyms. These synonymies could not be confirmed in this study because of the non-availability of relevant material.

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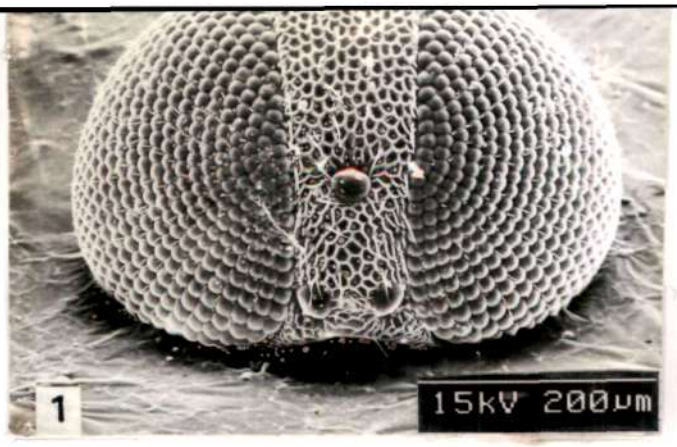
* References not consulted in the original. These were noted from other publications.

Figs. 1-5. SEM microphotographs: 1-4 Metaphycus zebratus (Mercet), female: 1. Head dorsum; 2. Head front view; 3. Antenna; 4. Part of fore wing. 5. M. longiclavatus (Shafee et al.), female, palps.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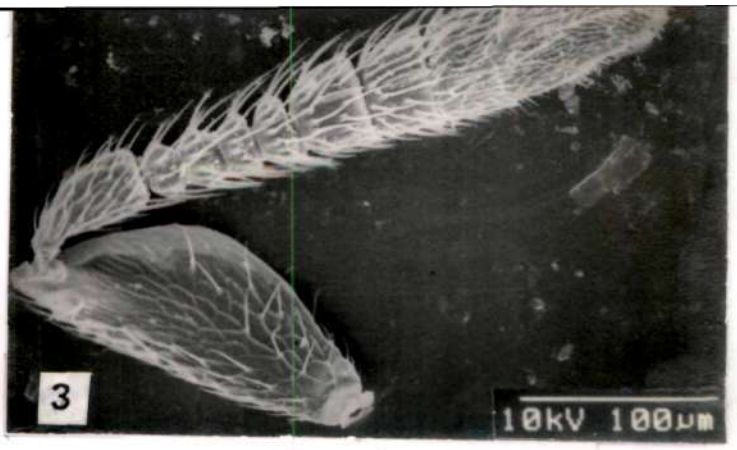
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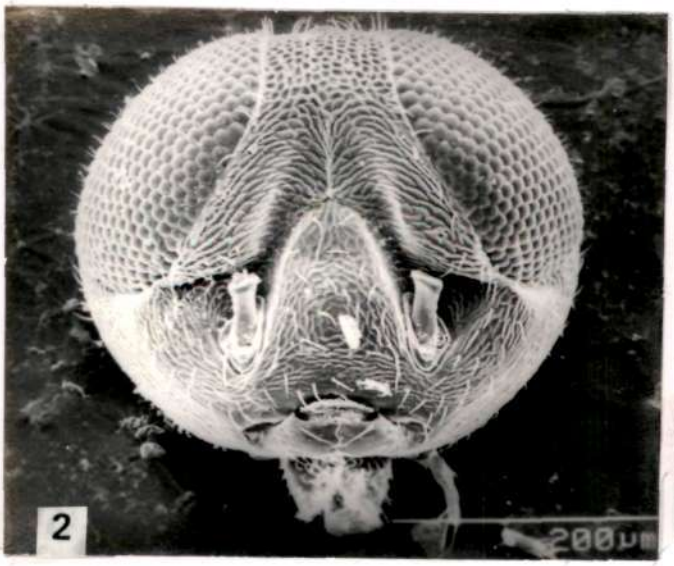
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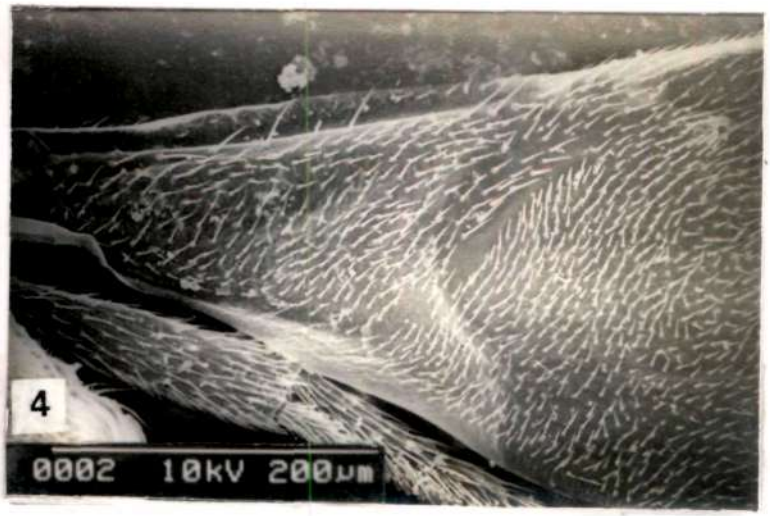
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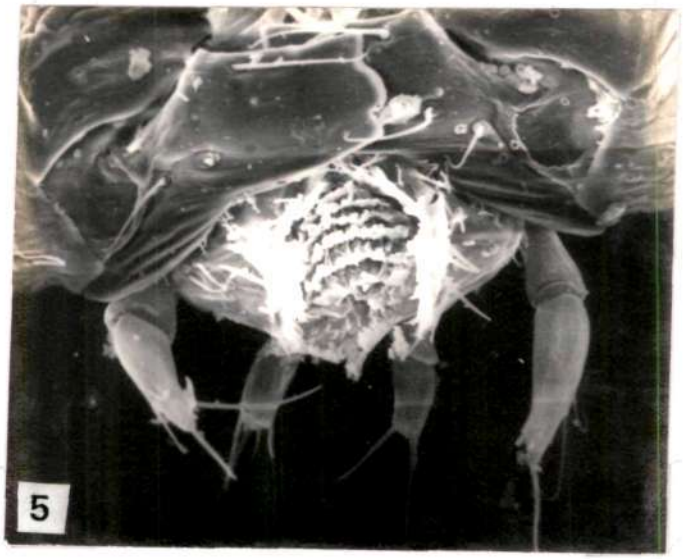
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Figs. 6–9. SEM microphotographs: (6) Metaphycus crotolariae (Shafee et al), female: 6. Thorax, dorsum. 7. Metaphycus sp. female, part of mesoscutum. 8. M. zebratus (Mercet), female, part of thorax. 9. M. crotolariae, male, antennal torulus. Arrows in figures 7 and 8 indicate notaular lines, in figure 9 sensory area.

200µm
6


×600 0000 15kV 50µm
7

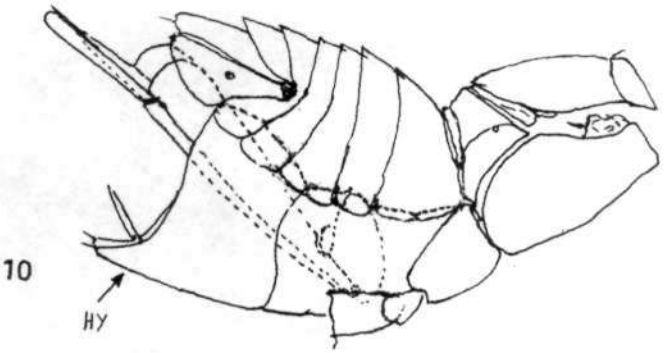

×400 0003 10kV 100µm
8


10kV 20µm
9

Figs. 10-14. Aphycus sp., female: 10. Part of thorax and gaster, in profile showing prominent hypopygium(Hy); 11. Apical terga of gaster, T VII=last tergum; 12. Hypopygium; 13. part of fore wing BC=basal cell; FS=filum spinosum; 14. Mandible.

Figs. 15-20. Metaphycus spp., female: 15. M. zebratus (Mercet), pronotum. 16. M. crotolariae (Shafee et al), apex of gaster (Hy = Hypopygium). 17. M. zebratus, apical terga of gaster (T VII = last tergum). 18. M. crotolariae, hypopygium. 19. M. latiscapus Alam, palps. 20. M. maculatus Agarwal, palps.

Fig. 21. M. zebratus, male genitalia; PB = Phallobase, DV = digitus volsellaris, AE = aedeagus, AA = aedeagal apodemes.

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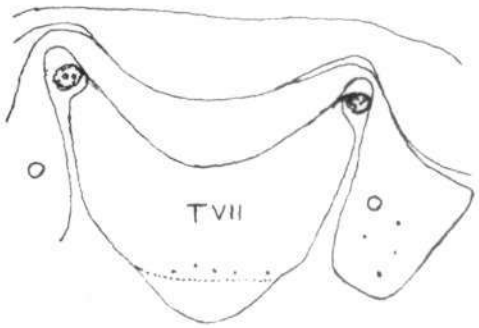


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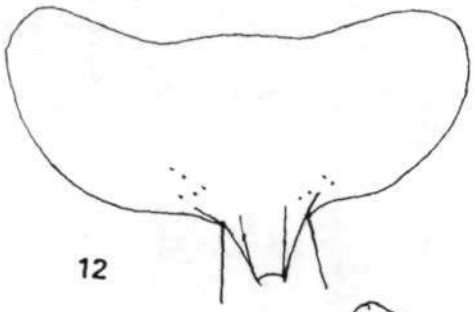

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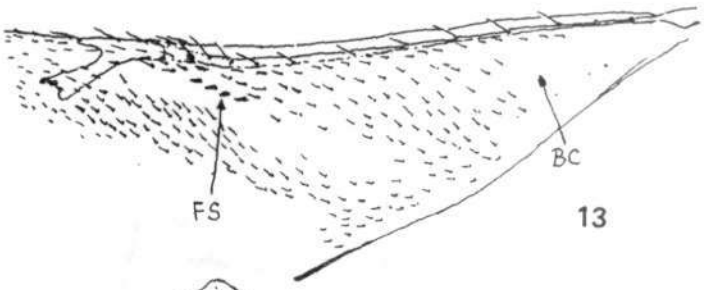


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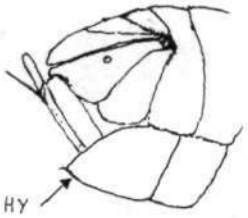


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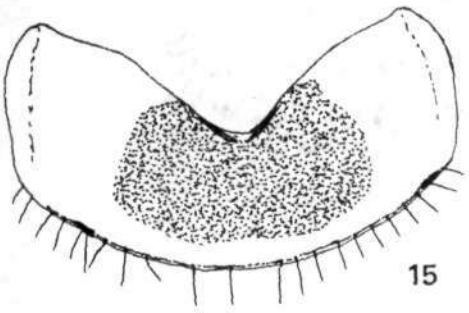

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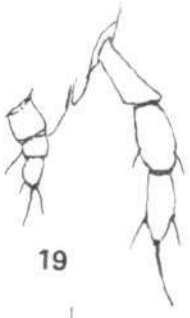

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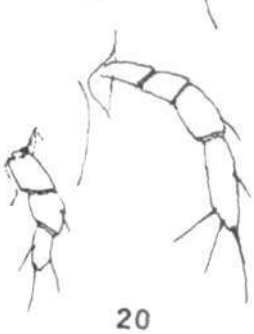

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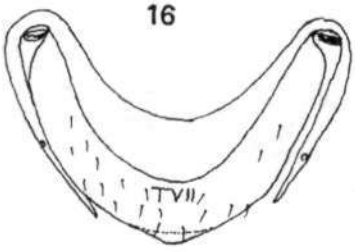


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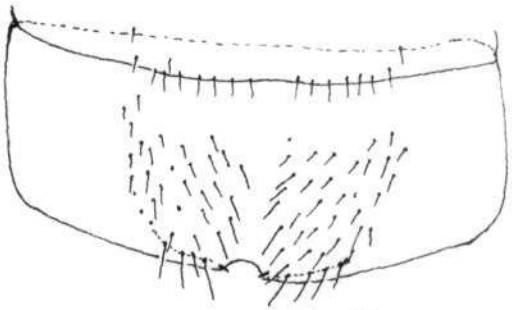

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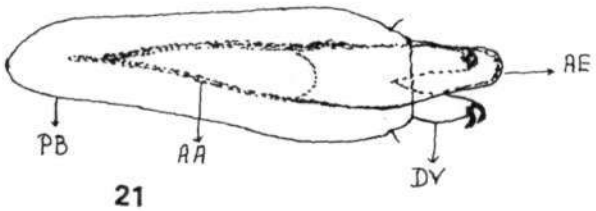


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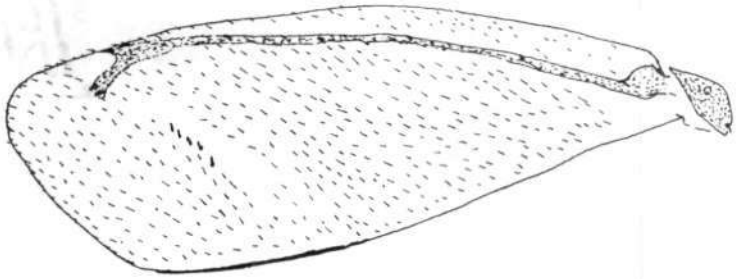
Figs. 22-29. (22,23) Metaphycus brevielus Kaul & Agarwal, holotype, female: 22 Antenna; 23. Fore wing. (24-29) M. zebratus (Mercet), female except fig. 29: 24. Antenna; 25. Antennal scape and pedicel; 26. Thorax dorsal; 27. Second valvifer and third valvula; 28. Middle tibia and basitarsus, drawn on same scale as fig. 27; 29. Antenna, male.



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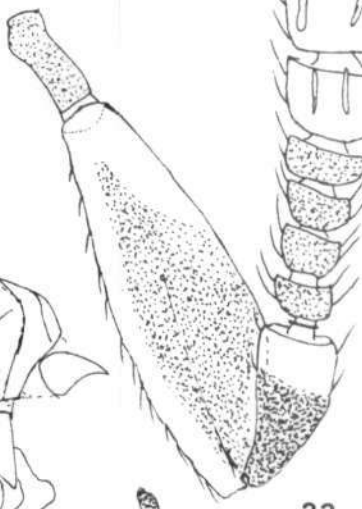

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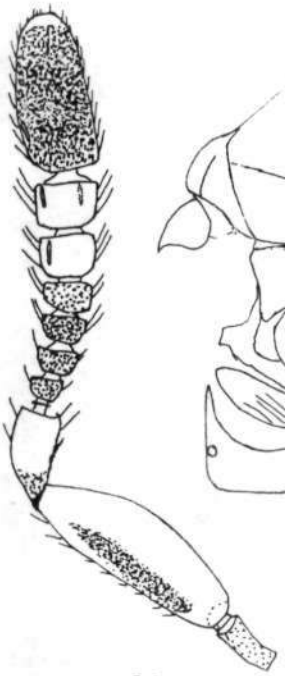

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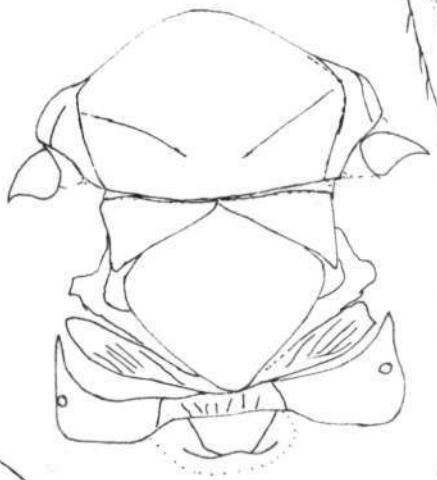

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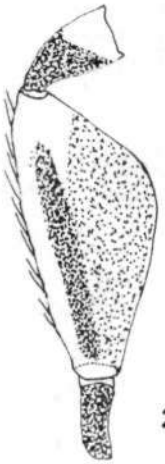

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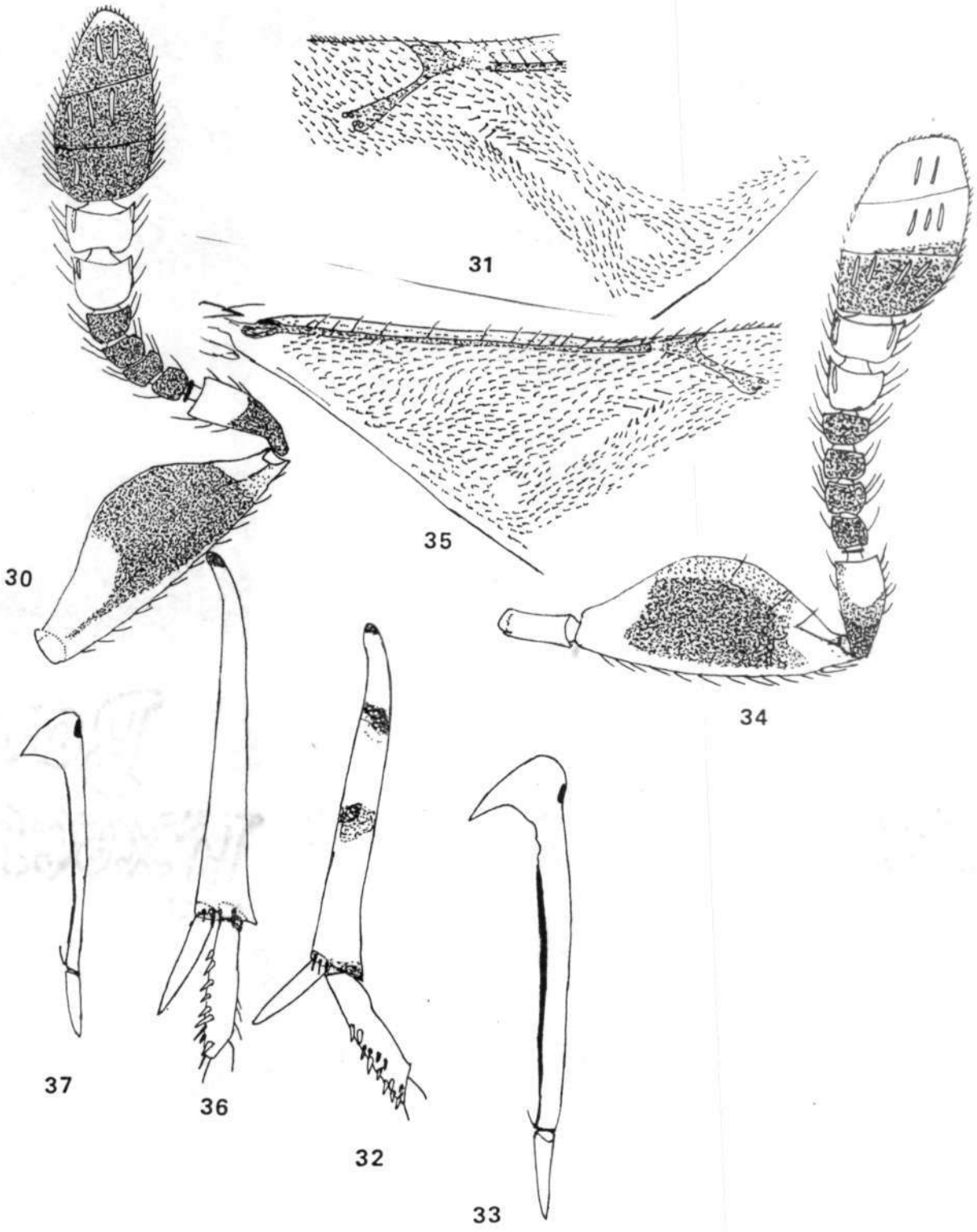
Figs. 30-37. (30-33) Metaphycus maculatus Agarwal, Paratype female: 30. Antenna; 31.Part of fore wing showing venation and linea calva; 32. Middle tibia and basitarsus; 33. Second valvifer and third valvula, drawn on same scale as fig. 32. (34-37) M. indicus Shafee et al, female: 34. Antenna; 35, Part of fore wing; 36. Middle tibia and basitarsus; 37. Second valvifer and third valvula, drawn on same scale as fig. 36.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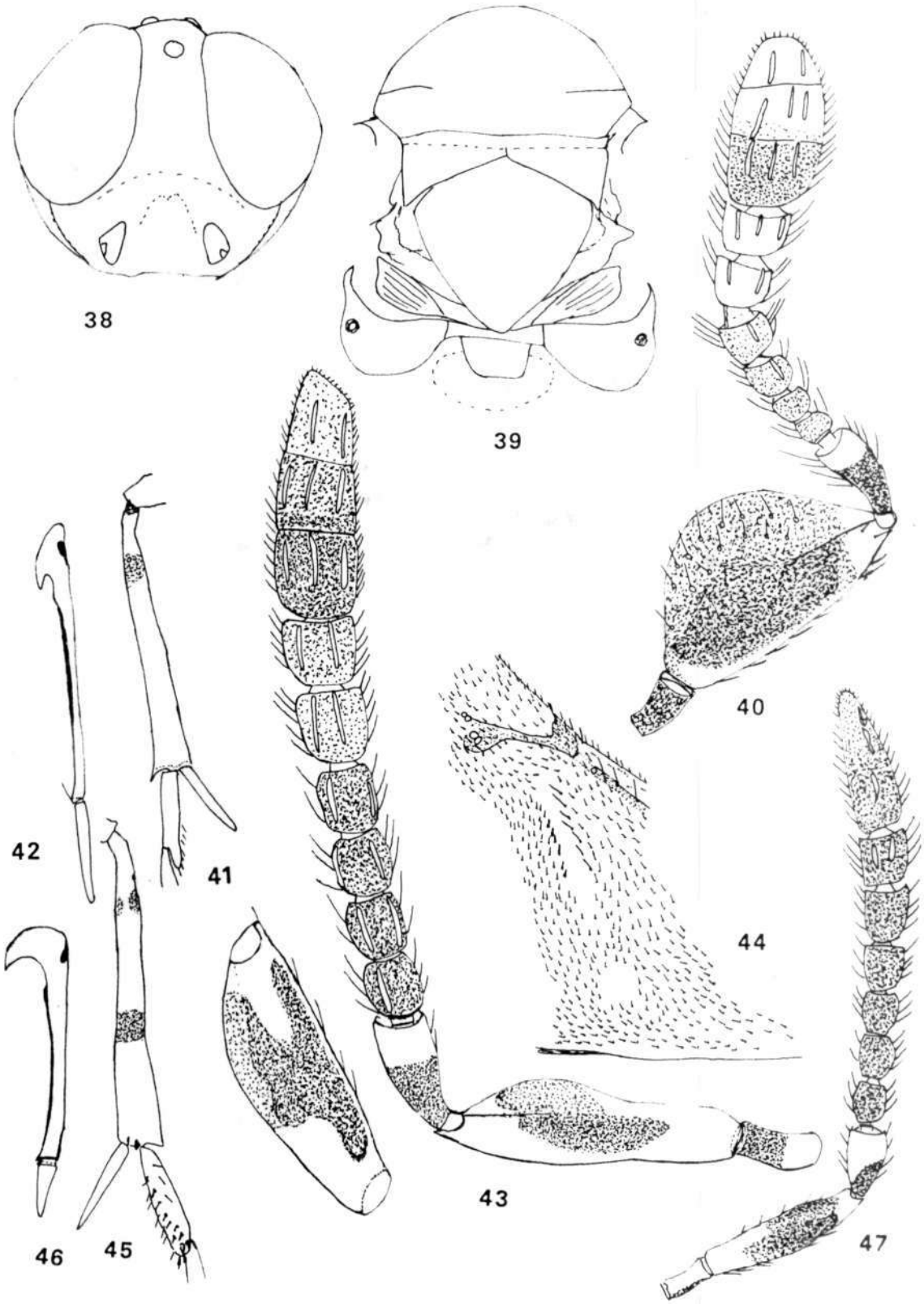
Figs. 38-47. (38-42). Metaphycus latiscapus Alam, female: 38. Head frontal view; 39. Thorax, dorsal; 40. Antenna; 41. Middle tibia and basitarsus; 42. Second valvifer and third valvula, drawn on same scale as fig. 41. (43-47) M. crotolariae(Shafee et al), female except fig. 47: 43. Antenna, with scape from another antenna to show actual width; 44. Part of fore wing showing venation and linea calva; 45. Middle tibia and basitarsus; 46. Second valvifer and third valvula, drawn on same scale as fig. 45; 47. Antenna, male.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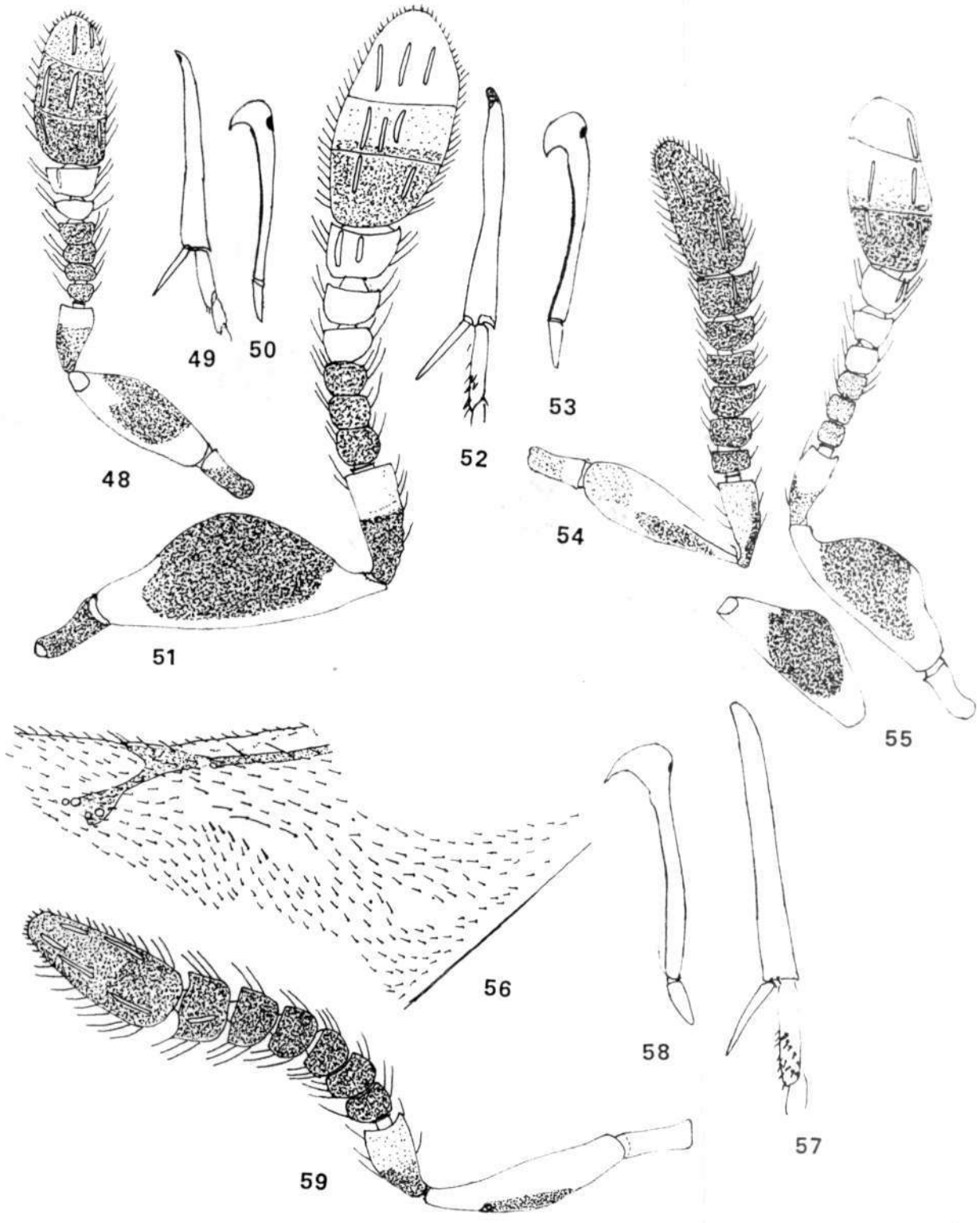
Figs. 48-59. (48-54) Metaphycus longiclavatus (Shafee et al.), female, except fig. 54: 48. Antenna; 49. Middle tibia and basal two tarsal segments; 50. Second valvifer and third valvula, drawn on same scale as fig. 49. 51. Antenna; 52. Middle tibia and basitarsus; 53. Second valvifer and third valvula, drawn on same scale as fig. 52; 54. Antenna, male. Figs. 48-50 drawn from a paratype, which is a smaller specimen. (55-59) M. gilvus Compere, female, except fig. 59: 55. Antenna, with scape from a second specimen; 56. Part of fore wing showing venation and linea calva; 57. Middle tibia and basitarsus, 58. Second valvifer and third valvula, drawn on same scale as fig. 57; 59. Antenna, male.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